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(52) UK CL (Edition R )

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(58) Field of Search

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INT CL<sup>7</sup> B60R 13/08 , B62D 1/16 1/18 , B63H 23/32 ,  
F04D 29/10 , F16D 3/84 , F16J 3/02 3/04 15/32 15/52  
15/54  
Online WPI, EPODOC, JAPIO

(54) Abstract Title

**A seal for use, and accommodating angular misalignments, between a steering shaft and an opening through a dash panel of a motor vehicle**

(57) A seal which accommodates angular misalignments between a rotatable steering shaft (15) of a motor vehicle and a dash panel (10) where the shaft passes through an opening (5) in the dash panel is described. The seal comprises a flexible outer ring (25) having a shape similar to that of the opening (5) in the dash panel and having a size sufficient to overlap the edge of the opening, the outer ring also having means (50) for projecting through the opening and securing the outer ring in sealing contact with the dash panel; an inner ring (28) holding a seal/bearing assembly (35), the seal/bearing assembly having a body (33) with an outer surface in sealing engagement with the inner ring and a seal/bearing (40) with an outer bearing surface, rotatable in the body, and having an inner sealing surface congruent with an outer surface of the steering shaft; and a diaphragm (27) for providing a sealing connection between the inner (28) and outer (25) rings.

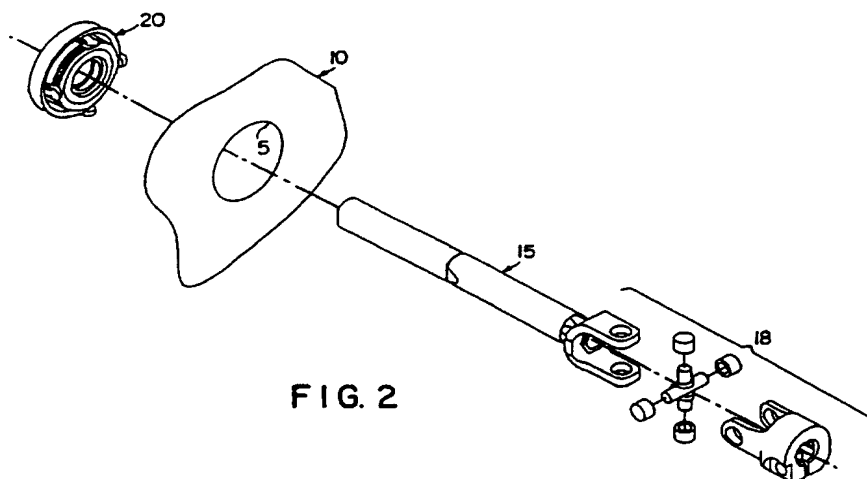


FIG. 2

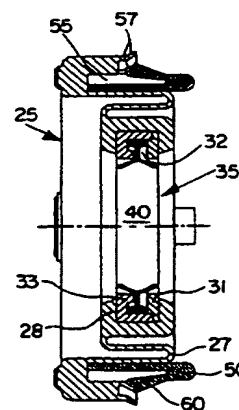
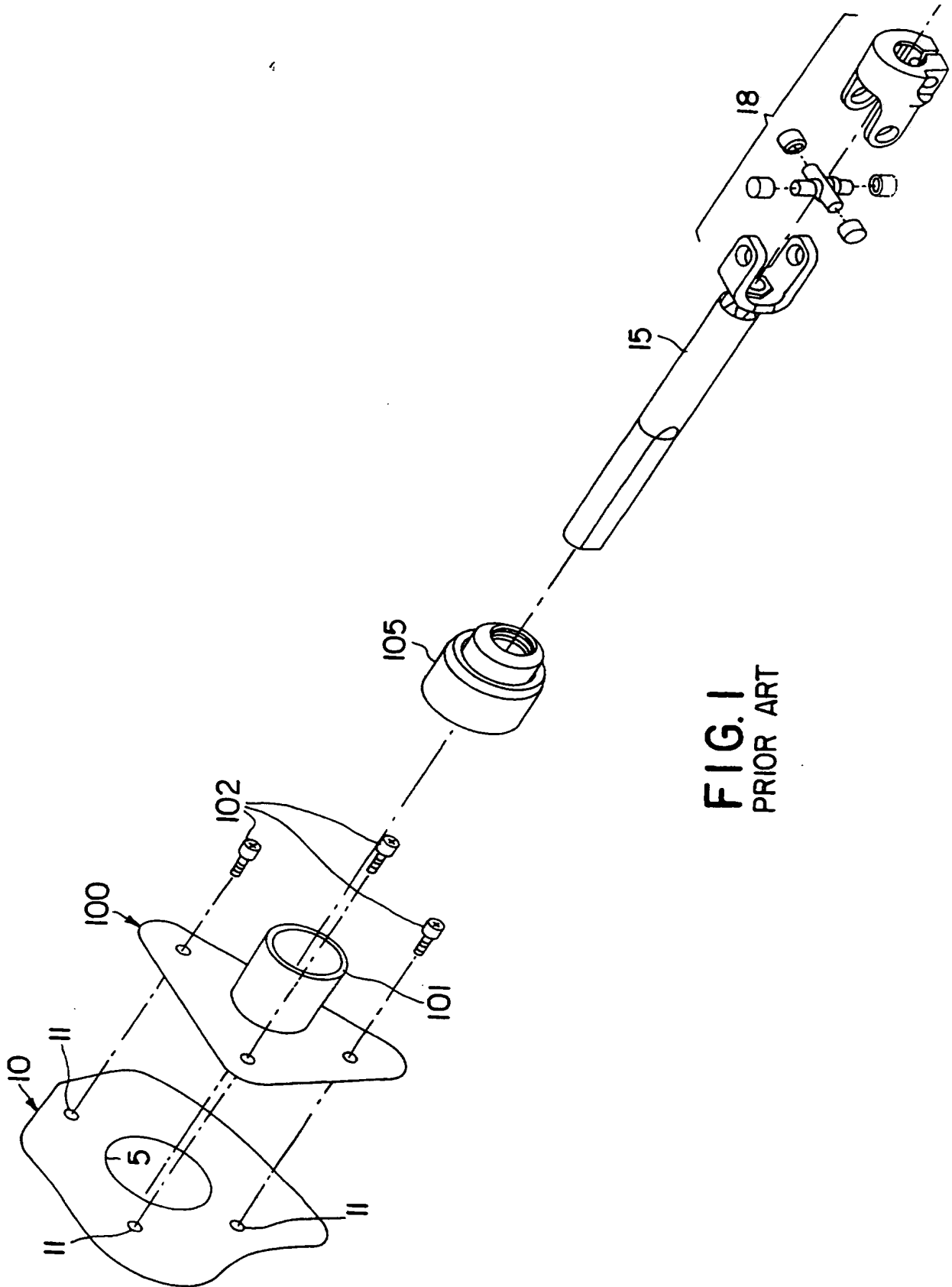


FIG. 3b

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**FIG. 1**  
PRIOR ART

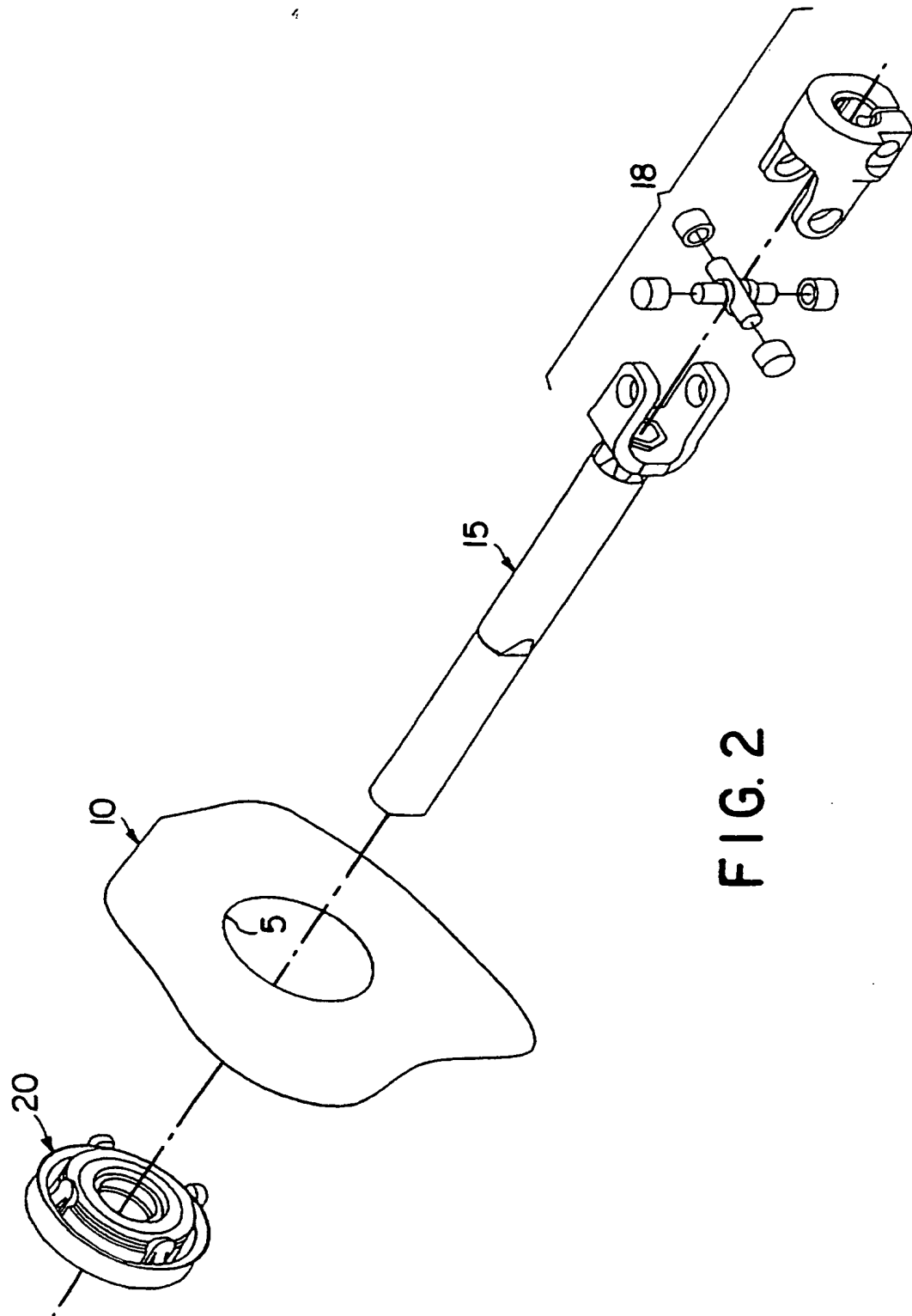
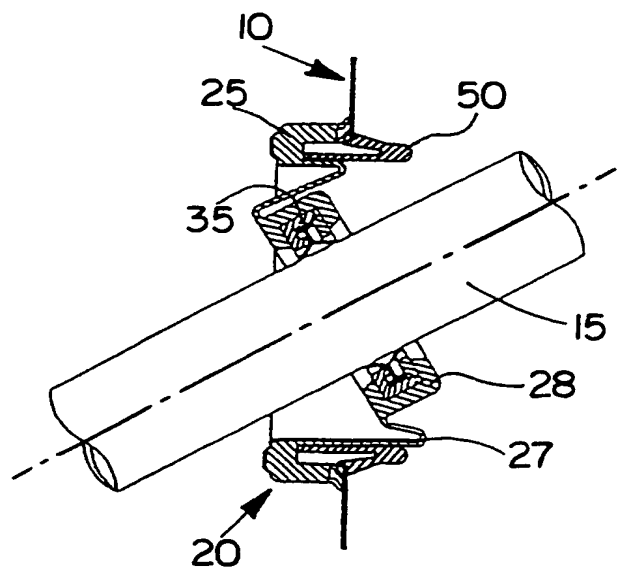
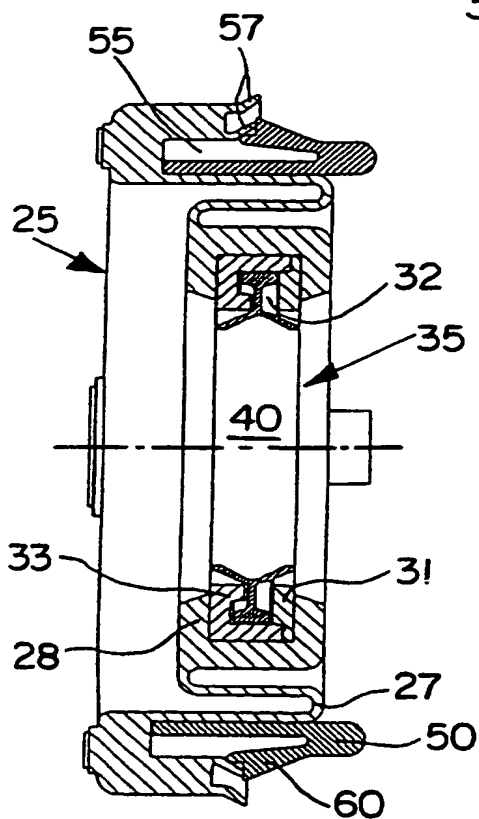
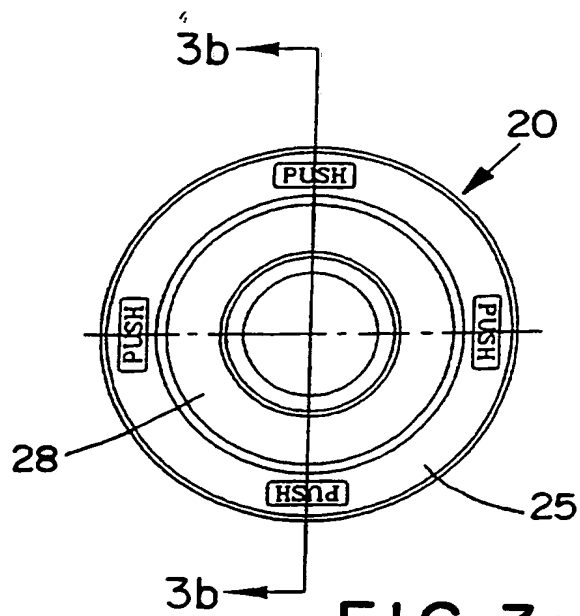


FIG. 2



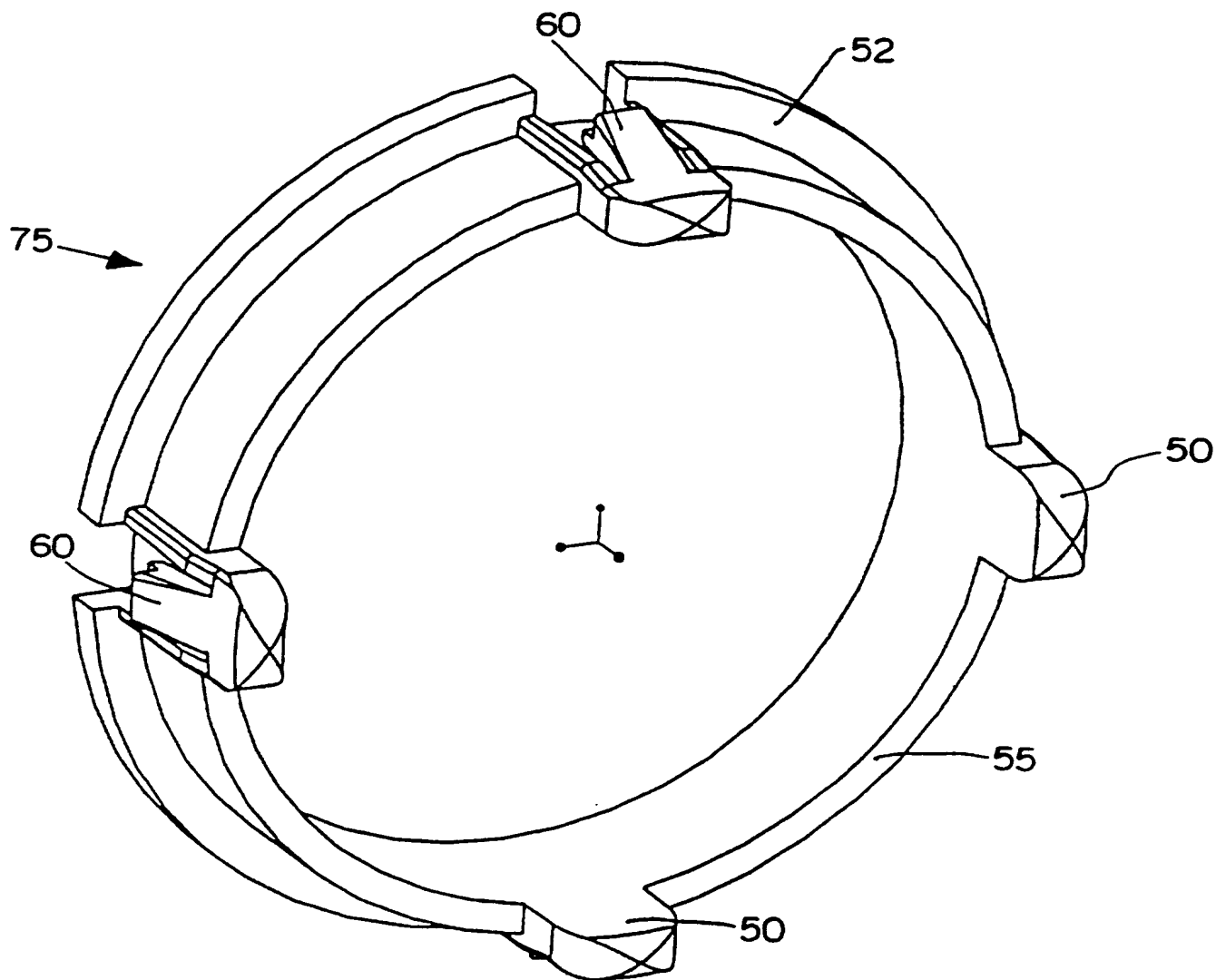


FIG. 4

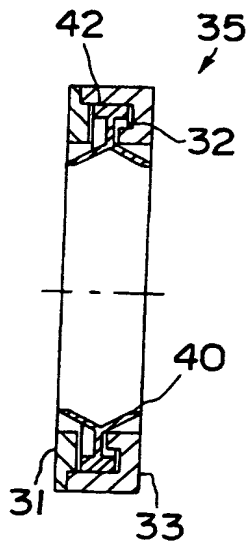


FIG. 5a

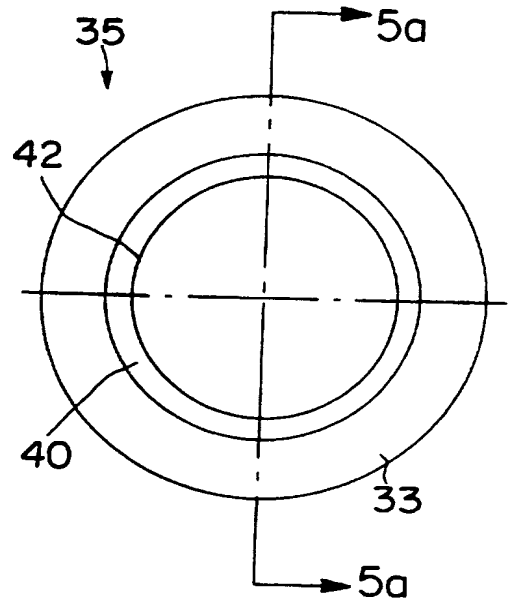


FIG. 5b

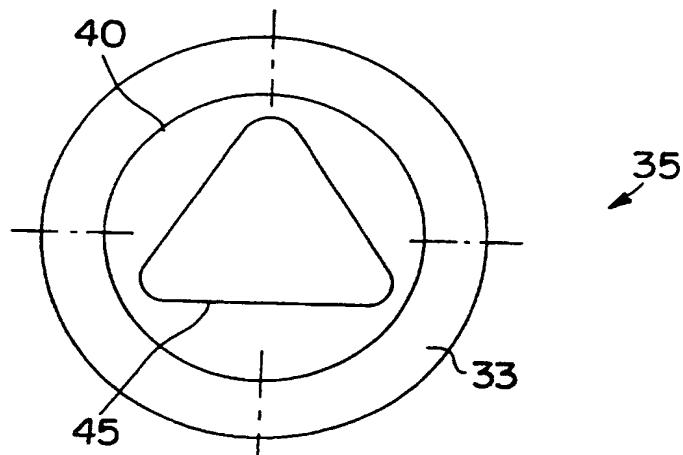


FIG. 5c

SEAL FOR USE BETWEEN A STEERING SHAFT AND AN OPENING  
THROUGH A DASH PANEL OF A MOTOR VEHICLE

5 This invention relates generally to motor vehicle steering systems and more particularly to devices for sealing around steering shafts where they pass through a dash panel of a motor vehicle between the engine compartment and the passenger compartment.

10 The passenger compartment of a motor vehicle is isolated from the engine compartment in order to exclude temperature extremes, water, dirt, fumes and noise. For this purpose, all parts passing through the partition separating the engine and passenger compartments have  
15 seals which conform to the shapes of the parts and the passage holes.

20 Before the advent of weight reduction of vehicles for fuel economy and before introduction of adjustable and collapsible steering columns for comfort and safety, steering shafts were commonly enclosed in a stationary mast jacket which passed through the partition and had a stationary seal interface with the partition, similar to  
25 the grommets around wires and other small objects which penetrated the partition. Those static seals were rather simple and were very durable and reliable. The elimination of the full-length mast jackets together with the introduction of adjustability was accompanied by new  
30 difficulties in installation alignment, silencing and vibration damping which could not be fully addressed by the formerly used static seals.

Intermediate shafts in many current steering systems pass through the engine compartment dash panel and

require an interface seal that is quiet with minimal rotational drag as the intermediate shaft is rotated. In addition, the seal must accommodate slight angular misalignments and mis-locations of the shaft relative to the hole in the dash panel, due to manufacturing tolerance accumulation, during assembly and operation.

Several sealing devices have been used over the years, to address the requirements above, with varying degrees of success. Commonly, these include a gasketed toe plate with a tubular projection surrounding the opening in the dash panel, which is fastened to the dash panel at the appropriate location, and a sealing member for sealing between the tubular member of the toe plate and the steering shaft. Such sealing devices are platform-specific, in that each vehicle model requires a specific seal design because of differences of placement and angle of the steering column with respect to the steering gear box and the dash panel partition of the particular vehicle design. Generally, sealing performance is adequate initially, but assembly is difficult due to the necessity of installing several parts while achieving proper alignment between the fasteners, the attachment holes of the toe plate, and the holes in the dash panel under the space limitations existing beneath the vehicle dash and between the dash panel and steering gear box. In addition, as the seal ages and becomes less pliable and more contaminated, it can begin to produce squeaks and other noises during operation of the vehicle.

According to the present invention, there is a device for sealing and for accommodating angular misalignments between a rotatable steering shaft of a



motor vehicle and a dash panel separating a passenger compartment and engine compartment where said shaft passes through an opening in said dash panel, said seal comprising an outer ring member having a shape similar to that of the opening in said dash panel and having a size sufficient to overlap the edge of said opening, said outer ring member also having means for projecting through said opening and engaging with said dash panel to secure said outer ring member in sealing contact with said dash panel, an inner ring member holding a seal/bearing assembly, said seal/bearing assembly having a body with a circular outer surface in sealing engagement with said inner ring member and a seal/bearing with a circular outer bearing surface, rotatable in said body, and having an inner seal surface congruent with an outer surface of said steering shaft, and a flexible membrane for providing a sealing connection between said inner ring member and said outer ring member.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Fig. 1 is a schematic exploded isometric view of a steering shaft sealing device of the prior art;

Fig. 2 is a schematic exploded isometric view of the present steering shaft sealing device;

Figs. 3A, 3B and 3C show an axial view of the present sealing device, a transverse sectional view along the line and in the direction of arrows B-B of

Fig. 3A, and a transverse sectional view installed in a dash panel about a steering shaft, respectively;

Fig. 4 is a schematic isometric view of a retainer clip of the present sealing device; and

Figs. 5A, 5B and 5C are a transverse cross-sectional view, and an axial view of an inner ring member for a cylindrical shaft and a non-cylindrical shaft, respectively.

A known sealing device is shown in Fig. 1. It shows a steering shaft 15 with an exploded view of a universal joint 18. The sealing device is designed for mounting at an opening 5 in an engine compartment dash panel 10, which has holes 11 for receiving fasteners 102 from a toe plate 100. The toe plate has a tubular protrusion 101 extending from its surface surrounding the hole 5 at an angle specific to the vehicle in which it is used. A static flexible seal 105 fits over the protrusion 101 and seals between the protrusion and the steering shaft 15. White grease or other lubricant is applied between the seal 101 and the shaft 15 to reduce friction and prevent squeaking during axial vibration and rotation of the shaft. Such sealing devices accommodate only minimal misalignments between the shaft 15 and the opening 5 in the dash panel 10.

The present sealing device is shown in Fig. 2. The steering shaft 15 with its exploded universal joint 18 is the same as in Fig. 1. Here, the dash panel 10 has only the opening 5, since separate fasteners are not needed by the seal assembly 20. Figs. 3A, 3B and 3C show further details of the present seal assembly 20.

In the preferred embodiment, there are four clips 50 extending axially from a retainer ring 75 (Fig. 4) which secure the seal assembly 20 to the dash panel 10. The seal consists of a boot which has an inner ring 28 and an outer ring 25 connected by a flexible membrane 27. This allows radial, axial and angular displacement between the inner and outer rings. The outer ring has sealing features 57, which may be alternating lips and grooves or other labyrinth-forming features, on the dash panel-sealing face. The inner ring 28 holds a seal/bearing assembly 35 (Figs. 5A, 5B, 5C), which consists of a body 33, a lid 31 and a seal/bearing 40 held within an annular cavity 32 between the body and the lid. Note that the seal/bearing body could be moulded as a single piece depending on its size and the size and flexibility of the seal/bearing. The seal/bearing 40 has a circular outer bearing surface, which is rotatable in the cavity 32, and an inner sealing surface that is congruent with the outer surface of the steering shaft 15, which may be circular 42, as in Fig. 5B, or non-circular 45, as in Fig. 5C.

The boot, comprising the outer ring 25, the inner ring 28, and the flexible membrane 27 of the seal assembly 20 is preferably moulded as a single piece from a polymer having the required flexibility for sealing against the dash panel, while the retainer 75 is moulded from a polymer with a higher durometer value. Similarly the body 33 and lid 31 of the seal/bearing assembly 35 are preferably moulded from a high-durometer polymer, while the seal/bearing 40 is preferably moulded from a lower durometer polymer than are the body 33 and the lid 31, as required for sealing between the steering shaft 15 and the seal/bearing body 33. The inner and outer rings

could be moulded around metal ring forms, as could the seal/bearing body and lift for some applications. The retainer could also be formed from metal, but, for the sake of corrosion avoidance, silencing and moulding simplicity, it is preferred to mould all parts of the assembly from polymers of the appropriate durometer values.

Lubricant is provided in the cavity 32 of the seal/bearing body 33 to reduce friction between the seal/bearing 40 and the seal/bearing body 33 and between the steering shaft 15 and seal/bearing 40.

The retainer ring 75 shown in Fig. 4 has a body 55 with a flange 52 which is either moulded in place in the outer ring 25 of the seal assembly 20 or is installed in a retainer cavity which is pre-moulded in the outer ring. Preferably four clips 50 extend axially from the body 55 of the retainer. Depending on the size of the opening to be sealed and the stiffness of the seal assembly 20, either more or fewer clips may be required. Each clip 50 has a tapered distal end with radially extending pawls 60 proximal to the body 55. The pawls 60 flex radially inwardly under the reaction force from the dash panel 10 during insertion and act as barbs which snap outwardly behind the dash panel 10 to hold the seal assembly 20 against the dash panel 10 once it has been pushed into place and the sealing features 57 compressed.

The sealing device here described provides the advantages of cost reduction due to elimination of the toe plate and fasteners and the labour for installing them; improved ergonomics making it easier to install the device in a vehicle during assembly; and reduced noise potential due

to the all-polymer construction. In addition, because it can better tolerate run-out and misalignment between the steering shaft and the opening in the dash panel, the device can be applied to several different vehicles. This allows standardisation of the opening in the dash panel. All shapes (round, D-D, square, triangular, etc.) of the steering shaft and a wide range of angles between the steering shaft and the dash panel can be accommodated by a single device; because of the bearing/seal design and because of the generous flexibility of the boot or the seal assembly. Also, installation can easily be done from either side of the dash panel - from the engine compartment or the passenger compartment.

CLAIMS

1. A device for sealing and for accommodating angular misalignments between a rotatable steering shaft of a motor vehicle and a dash panel separating a passenger compartment and engine compartment where said shaft passes through an opening in said dash panel, said seal comprising an outer ring member having a shape similar to that of the opening in said dash panel and having a size sufficient to overlap the edge of said opening, said outer ring member also having means for projecting through said opening and engaging with said dash panel to secure said outer ring member in sealing contact with said dash panel, an inner ring member holding a seal/bearing assembly, said seal/bearing assembly having a body with a circular outer surface in sealing engagement with said inner ring member and a seal/bearing with a circular outer bearing surface, rotatable in said body, and having an inner seal surface congruent with an outer surface of said steering shaft, and a flexible membrane for providing a sealing connection between said inner ring member and said outer ring member.

2. A device according to claim 1, wherein the means of projecting through said opening and engaging with said dash panel comprises a circular retainer with a plurality of distally tapered clips projecting axially therefrom and having proximally situated radially extending pawls, the proximal edge of said retainer being captured within said outer ring member such that, when the ring member is pressed against the dash panel and the radially extending pawls of the retainer engage the

distal side of the dash panel, the ring member is secured in sealing engagement with said panel.

3. A device according to claim 1 or 2, wherein a face of said outer ring member has flexible alternating circumferential lips and grooves which compress when said outer steering member is pressed against the dash panel.

4. A device according to claim 1, 2 or 3, wherein all elements of said seal/bearing assembly are fabricated from moulded polymers.

5. A device according to claim 2, wherein the retainer is fabricated as a moulded polymer.

6. A device according to any one of the preceding claims, wherein said seal/bearing body has a separable lid for installation of said seal/bearing in said body.

7. A device for sealing and for accommodating angular misalignments between a rotatable steering shaft of a motor vehicle and a dash panel, substantially as hereinbefore described, with reference Figures 2 to 5 inclusive of the accompanying drawings.



INVESTOR IN PEOPLE

Application No: GB 0000013.3  
Claims searched: 1-7

Examiner: Kevin Hewitt  
Date of search: 26 April 2000

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B7H (HFC), F2B (B13C)

Int Cl (Ed.7): B60R (13/08), B62D (1/16, 1/18), F04D (29/10), F16D (3/84), F16J (3/02, 3/04, 15/32, 15/52, 15/54), B63H (23/32)

Other: Online WPI, EPODOC, JAPIO

### Documents considered to be relevant:

| Category | Identity of document and relevant passage                       | Relevant to claims |
|----------|---|--------------------|
| Y        | EP 0805090 A1 (Cabinet Martinet & Lapoux) See Figs.1&4          | 3,4,5              |
| X        | US 4840386 A (Daimler Benz) See Fig.1, whole document relevant. | 1,2                |
| Y        |   | 3,4,5              |

|   |   |   |  |
|---|---|---|--|
| X | Document indicating lack of novelty or inventive step   | A | Document indicating technological background and/or state of the art.  |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention.          |
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